MAY 2 1979

MEMORANDUM FOR: K. Kniel, Chief, Core Performance Branch, DSS

FROM: H. Richings, Reactor Physics Section, CPB, DSS

SUBJECT: TMI2 STARTUP RANGE COUNTS FROM D(γ, m)

This is a brief note to estimate the possibility that the apparently abnormally high count rate observed on the TMI2 startup range excore neutron detectors (BF_3 proportional counters) may come in part from D(γ, m) reactions in the downcomer region rather than from the "normal" source multiplication in the core.

A possibility that the count rate could originate from such a source was (in part) suggested by the observation (M. A. Schultz) that there may be a 12 day half life correlation to the count rate, which could indicate Ba^{140}, La^{140} decay, with the La^{140} 2.53 MeV gamma providing a neutron source from interactions with the D_2O (need at least 2.3 MeV gamma). This note provides a partial numerical estimate for that possibility.

Assuming the neutron source comes only from La^{140}, the 4/11/79 primary coolant sample analysis indicated a La^{140} concentration of about 150 microcuries per cm^3, or about 5×10^6 disentegrations per second per cm^3.

Since the γ, m cross section is about 10^{-3} times the (primary energy loss at 2.5 MeV) Compton cross section, in an infinite D medium there will be about one neutron for 1000 gammas.

Since in the 2 MeV range the Compton cross section is proportional to mass, in a D_2O medium there will be about 4 oxygen Compton reactions for every D reaction, thus the neutron reactions are reduced by 1/5. The D/H ratio 0.00015 also reduces the reaction rate.

Only about 3% of the La^{140} decays produces a 2.53 MeV gamma.

Combined we have $5 \times 10^6 \times 10^{-3} \times 1/5 \times 0.00015 \times .03$, or about 5×10^{-3} neutrons/second/cm^3 (on April 11).

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In the downcomer region there should be a region about 12 feet high, 5 feet wide and 10 inches thick.in which neutrons which are boron (at about 10^3 eV) can be expected to reach the detector with any useful degree of probability. There are about 7000 neutrons per second produced in that region. If there are to be the order of 10 counts/second in the detector then one out of 700 of the neutrons must reach and be absorbed in the detector. Geometric view factors are about 1/70, so that means about one in ten neutrons must also be appropriately slowed down in the downcomer or shield and absorbed in the BF_3. This would appear to be a rather high probability for this latter process, but perhaps not totally out of the question.

Thus it is possible that γ-m neutrons from the downcomer region are contributing to the startup range detector count rate, but this estimate does not conclusively demonstrate it.

original signed by
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